Grids & Datums

Republic of Costa Rica

by Clifford J. Mugnier, C.P., C.M.S.

Inhabited by several indigenous tribes when reached by Christopher Columbus on his last voyage of 1502, the region became a Spanish province in 1540 although a permanent settlement was not established until the 1560s. “Christopher Columbus who stayed for 17 days in 1502 was so impressed by the gold decorations worn by the friendly locals that he promptly dubbed the country Costa Rica, ‘the rich coast.’ The 18th century saw the establishment of settlements such as Heredia, San José and Alajuela. It was not until the introduction of coffee in 1808, however, that the country registered on the radars of the 19th-century white-shoe brigade and frontier entrepreneurs looking to make a killing. Coffee brought wealth, a class structure, a more outward-looking perspective and, most importantly, independence. Costa Rica achieved independence from the Spanish Crown in 1821. A bizarre turn of events in 1856 provided one of the first important landmarks in the nation’s history and served to unify the people. During the term of coffee-grower-turned-president Juan Rafael Mora, a period remembered for the country’s economic and cultural growth, Costa Rica was invaded by the U.S. military adventurer William Walker and his army of recently captured Nicaraguan slaves. Mora organized an army of 9,000 civilians that against all odds, succeeded in forcing Walker & Co. to flee. The ensuing years of the 19th century saw power struggles among members of the coffee-growing elite and the institution of the first democratic elections, which have since been a hallmark of Costa Rican politics (Lonely Planet, 2007).”

Slightly smaller than West Virginia, Costa Rica is bordered by Nicaragua (309 km) and by Panamá (330 km) (*PE&RS,* July 2007), and has a coastline on both the Caribbean Sea and the North Pacific Ocean totaling 1,290 km. The climate is tropical with a dry season from December to April when it can rain about every other day and the rainy season when it can rain at least once a day – just like Panamá. Costa Rican terrain is mainly coastal plains separated by rugged mountains comprised of the Cordillera de Talamanca. The lowest points are sea level on the Pacific Ocean (lower than the Caribbean), and the highest points include Cerro Irazú (3,432 m), Cerro Barú (3,475 m), and Cerro Chirripó (3,819 m).

Cocos Island, called Coco by Costa Rica, is 4.8 km wide with a circumference of 20.8 km, has two good harbors in Chatham and Wafer Bays, and is 480 km southwest of Costa Rica and 880 km west southwest of Panamá City. It is formerly a whaling base and is now in good tuna fishing waters and is one of the strategic points of defense for the Panama Canal. An old legend says that treasure was buried there by the corsair Benito Bonito in 1818-1819, and more by one of his lieutenants in 1826. Another story has it that in 1821wealthy Spaniards, including the treasurer of the Cathedral, fleeing from Lima, Peru (*PE&RS,* May 2006) with gold and jewels aboard the *Mary Dier* were murdered in their bunks by the crew under an English Captain Thompson and that 12 boat loads of treasure worth about $30 million were afterwards buried on Cocos.

In 1888, the *Instituto Fisico Geográfico* (Physical Geography Institute) was established under the direction of Swiss Professor Henri Pittier, but the project lasted only until 1912. The Ocotepeque Datum of 1935 was established in Honduras *(PE&RS,* July 1999) at Base Norte where: Φ_o = 14° 26' 13.73" North (±0.07”), Λ_o = 89° 11' 39.67" West of Greenwich (±0.045”), h_o = 806.99 meters, the defining astronomic azimuth to Base Sur is: α_o = 235° 54' 20.37" (±0.28”), and the ellipsoid of reference is the Clarke 1866 where a = 6,378,206.4 meters and $1/f$ = 294.9786982. The corresponding geodetic coordinates are: φ_o = 14° 26' 20.168" North, λ_o = 89° 11' 33.964" West, and H_o = 823.40 meters above mean sea level. The defining geodetic azimuth to Base Sur is: α_o = 235° 54' 21.790" The differences between these two sets of coordinates are due to the local gravimetric deflection of the vertical as determined by Sidney H. Birdseye of the U.S. Coast & Geodetic Survey (USC&GS).

Apparently, someone in Costa Rica thought a Transverse Mercator was a good idea (not!) for a predominately East-West country. So much for the excellent advice and design of the IAGS ... a modified UTM is now only a mouse click away!

Nothing much happened (geodetically) anywhere in Central America during World War II. After the war, the U.S. Army Map Service (AMS) established the Inter American Geodetic Survey (IAGS) headquartered in the U.S. Canal Zone of Panamá at the picturesque Fort Curundu with most classrooms at Fort Clayton, as I remember. Co-operative agreements negotiated with most countries in Latin America included the Republic of Costa Rica. However, *“La Ley Numero 59”* (The Law, Number 59), was promulgated to establish the *Instituto Geográfico de Costa Rica* in 1944. In 1946, the *IGCR* signed an agreement with IAGS. The previous geodetic boundary work of the USC&GS (that established the Ocotepeque Datum of 1935), was integrated into the new IAGS observations along with the chains of quadrilaterals observed in Guatemala, Honduras, and Nicaragua (with the IAGS). With connections to the classical triangulation in Mexico, the North American Datum of 1927 (NAD 27) was eventually introduced to the Republic of Costa Rica. Of particular convenience was the fact that the Ocotepeque Datum of 1935 was referenced to the same

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ellipsoid! (That was courtesy of the USC&GS.) The IAGS observations in Costa Rica were supervised by Bill Parkhurst, my first mentor who I described for some of his later work in the Sudan (*PE&RS*, February 2008), and he trained Captain Frank Spacek, an officer in the U.S. Army Corps of Engineers (attached to the IAGS), in Costa Rica, and later Colonel Spacek was my Commanding Officer at Army Map Service in the 1970s when I was stationed there as a Captain.

The IAGS method of computing chains of quadrilaterals was the "Army way" of doing things. That way was different from the USC&GS because AMS was concerned with unifying the mish-mash of Datums in post-war Europe. The planning and design for that spectacular computational chore in Europe was ultimately accomplished with a conformal projection and Grid. The complexity of existing systems in the Americas was much simpler, but the Topographic Engineers of AMS (and IAGS), were trained according to the "Army way." That way consisted of computing classical triangulation on a conformal Grid. Central American countries, with the exception of Belize, are greater in east-west extent than in north-south extent. Therefore, the Lambert Conformal Conic projection was used as the basis of all IAGS-developed Grid systems in Central America for triangulation computations and the published "Trig Lists" of coordinates.

The Costa Rica Lambert Conformal Grid (1946 - present) on the Ocotepeque Datum of 1935 covers two secant zones, *Norte* and *Sud* (North and South Zones). Both zones use the same Central Meridian (λ_o) = 84° 20' 00" West of Greenwich, a False Easting of 500 km, and a scale factor at origin (m_o) = 0.99995696. Zone Norte has a Latitude of Origin (φ_o) = 10° 28' North, and the False Easting = 271,820.522 meters. Zone Sud has a Latitude of Origin (φ_o) = 9° 00' North, and the False Easting = 327,987.436 meters. Of course, these parameters will develop two *different* pairs of standard parallels for each zone because of their *different* respective latitudes of origin.

These ***secant*** Lambert Zones are defined according to the "British Method" which provides a Latitude of Origin (φ_o), and a Scale Factor at Origin (m_o). The common way to do it in the U.S. is the "American or French Definition" which provides for a pole-ward standard parallel and an equator-ward standard parallel for a *secant* zone. Much commercial GIS software as well as much "geodetic transformation" software mistakenly term this "British Definition" as a "tangent conic with one standard parallel." Patently false, this silly mis-classification shows that the mathematical foundation of a package's programming staff is apparently ignorant of cartographic/geodetic transformations and that they are presumably only capable of copying formulae from a book. For those that are capable of working with a bit of algebra, the math published in Chapter 3 of the *Manual of Photogrammetry*, 5th edition gives sufficient detail for a competent mathematician to equate the two Lambert "definitions" as mathematically equal. *(I did provide sufficient clues.)* One secant Lambert zone defined with a latitude at origin and a scale factor at origin less than one ***is the same*** as defining the zone with two standard parallels! A Lambert conformal conic zone is tangent if and only if *(iff),* the scale factor at origin is equal to unity! (That's "one" for those from Rio Linda.)

With regard to relating the old stuff to the new stuff, from Ocotepeque Datum of 1935 to WGS 72 Datum: ΔX = –193.798 m, ΔY = –37.807 m, ΔZ = +84.843 m. Furthermore, from Ocotepeque Datum of 1935 to the NAD1927: ΔX = +205.435 m, ΔY = –29.099 m, ΔZ = –292.202 m. In Costa Rica, the fit of Ocotepeque Datum 1935 to WGS 72 is better than ±3 m; the fit of NAD 27 to WGS 72 is better than ±6 m. On the other hand, *La Registro Nacional de la Republica de Costa Rica* offers the following parameters from Ocotepeque 1935 Datum to WGS84 Datum as: ΔX = –66.66 m ±0.27 m, ΔY = –0.13 m ±0.27 m, ΔZ = +216.80 m ±0.27 m, δs = –5.7649 ppm ±0.2.5657 ppm, R_x = +1.5657" ±1.0782", R_y = +0.5242" ±0.5318", R_z = +6.9718" 0.8313". No information is offered by the Costa Rican government regarding the sense of the rotations nor are example transformations given on the official web site. Beware of the sense of the rotations! A cryptic note is presented on the *Proyección CRTM90-WGS84* which is a "modified" UTM with a central meridian of 84°. Apparently, someone in Costa Rica thought a Transverse Mercator was a good idea **(not!)** for a predominately East-West country. So much for the excellent advice and design of the IAGS … a modified UTM is now only a mouse click away! The future arguments and disagreements between GIS Technicians and Licensed Land Surveyors will go on *ad nauseum* because the field-observed distances won't match the "correct" GIS-determined distances on the "modified" UTM-style *Proyección CRTM90-WGS84*! Cartographic ignorance is on the march – maybe the local academics can convince the government regarding the error of their ways. Military-style scale factors (0.9996) are good for military uses, but civilian-style scale factors (0.99995696) are much better for civilian uses, especially for lay people.

The contents of this column reflect the views of the author, who is responsible for the facts and accuracy of the data presented herein. The contents do not necessarily reflect the official views or policies of the American Society for Photogrammetry and Remote Sensing and/or the Louisiana State University Center for GeoInformatics (C^4G).